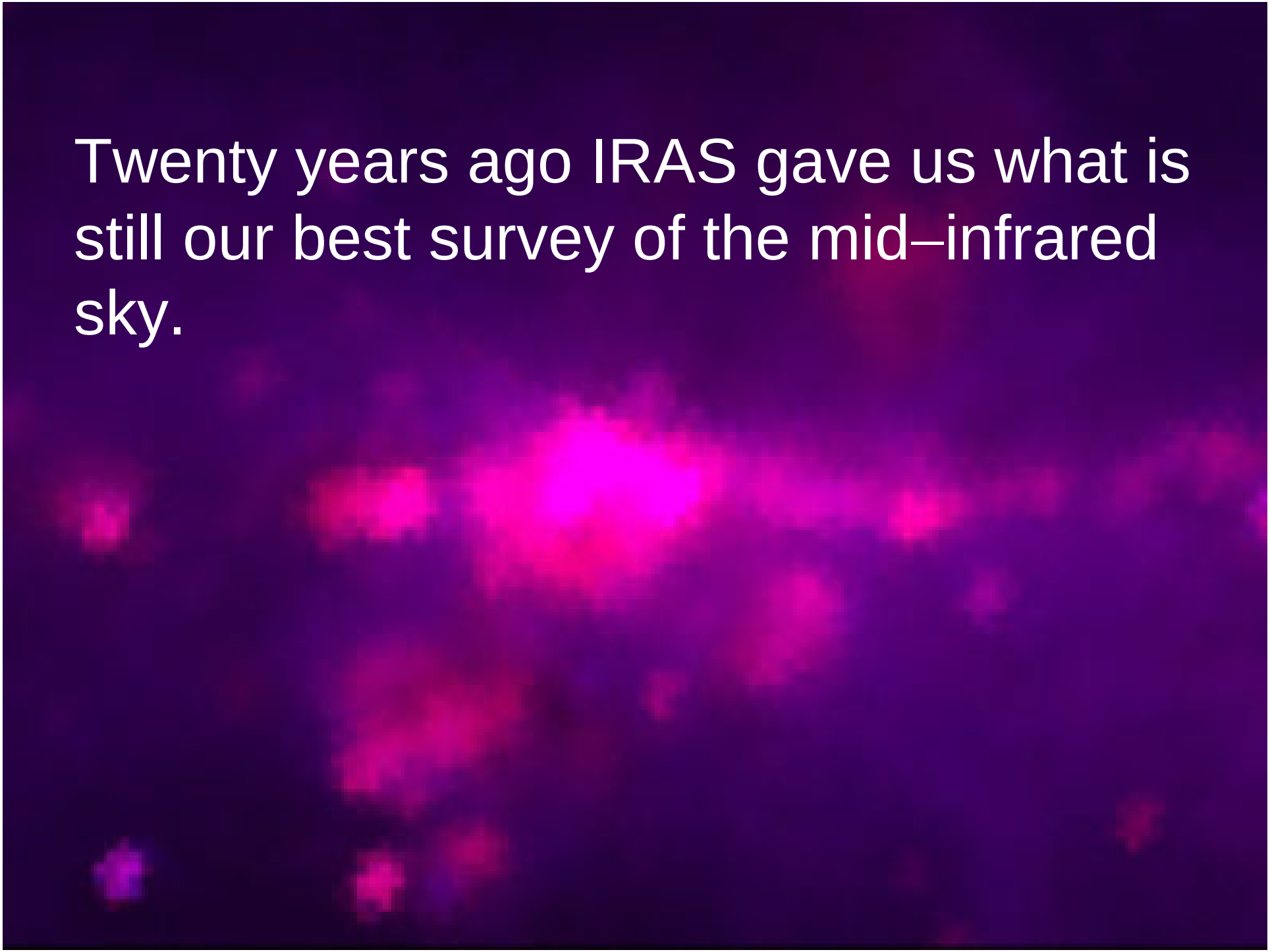
Wide-field Infrared Survey Explorer

Peter Eisenhardt,
Project Scientist

June 9, 2004


Twenty years ago IRAS gave us what is still our best survey of the mid–infrared sky.


WISE will map the sky with resolution comparable to the few square degrees shown here, achieving 500 times better sensitivity than IRAS.

What Is WISE?

- The Wide-field Infrared Survey Explorer (aka NGSS)
  - An all-sky survey at 3.5, 4.7, 12 & 23 μm with 500 to 500,000 times better sensitivity than previous surveys
  - A cold 40 cm telescope in a sun-synchronous orbit
  - Enabled by new infrared detector arrays
- A Medium Explorer (MIDEX) in Extended Phase A Study
  - JPL Project Manager is Spitzer alumnus Bill Irace
  - Phase B confirmation review scheduled for August 25, 2004
  - Launch planned for June 2008
- WISE will deliver to the scientific community
  - Over 1 million calibrated rectified images covering the whole sky in four infrared bands
  - Catalogs of $\approx 5 \times 10^8$ objects seen in these four IR bands

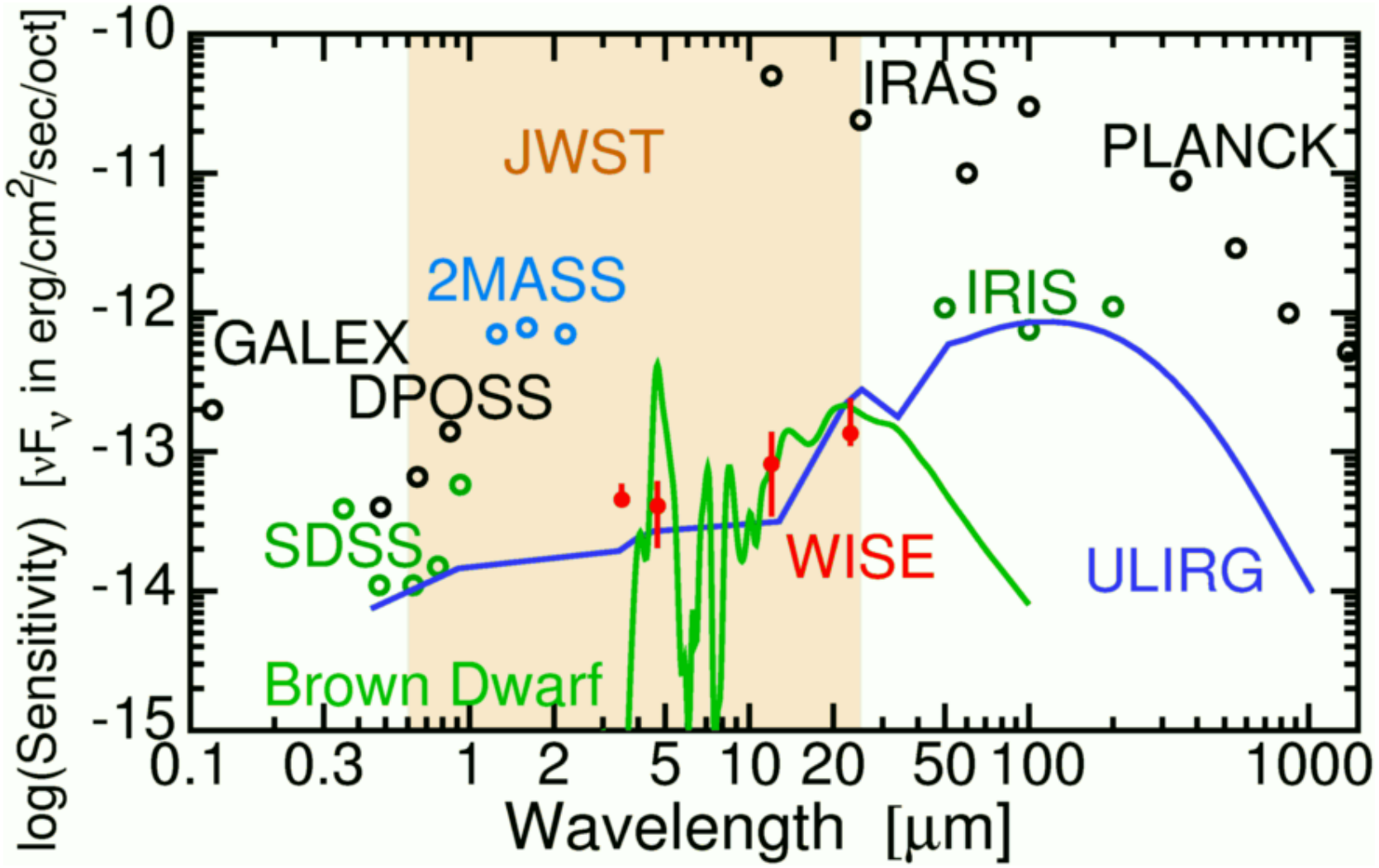
Wide-field Infrared Survey Explorer

WISE Science Team

Ned Wright	UCLA	COBE, WMAP, Spitzer	PI
Andrew Blain	Caltech	SCUBA	ULIRGs lead
Martin Cohen	Vanguard	IRAS, ISO, MSX	Calibration, Galactic Structure
Nahide Craig	UCB	RHESSI, THEMIS	E/PO lead
Roc Cutri	IPAC	IRAS, 2MASS	SDP lead, AGN
Peter Eisenhardt	JPL	Spitzer	Project Scientist
Nick Gautier	JPL	IRAS, Spitzer	Interstellar Dust
Isabel Hawkins	UCB	EUVE	E/PO
Tom Jarrett	IPAC	2MASS	Nearby Galaxies, SDP Pipeline
Davy Kirkpatrick	IPAC	2MASS	BDs lead, SDP QA
David Leisawitz	GSFC	COBE	Mission Scientist
Carol Lonsdale	IPAC	IRAS, 2MASS, SWIRE	ULIRGs, NVO coordination
John Mather	GSFC	COBE, JWST	NGST Coord, Large Scale Structure
Amy Mainzer	JPL	Spitzer	BD's, Payload Scientist
Ian McLean	UCLA	UKIRT, Keck, NIRSPEC	Detectors, Normal Galaxies
Robert McMillan	UA	Spacewatch	Asteroids lead
Deborah Padgett	IPAC	NICMOS, Spitzer	ISM, Star Formation
Michael Ressler	JPL	MIRLIN, MIRI	Detectors, Star Formation
Michael Skrutskie	UVa	2MASS PI	Star Formation, BD
Adam Stanford	UCDavis	Keck	Distant Galaxies, Clusters
Charles Steidel	Caltech	Keck	High Redshift Galaxies, LSS
Russell Walker	Vanguard	IRAS, MSX	Calib., Asteroids, Zodi Cloud

Wide-field Infrared Survey Explorer

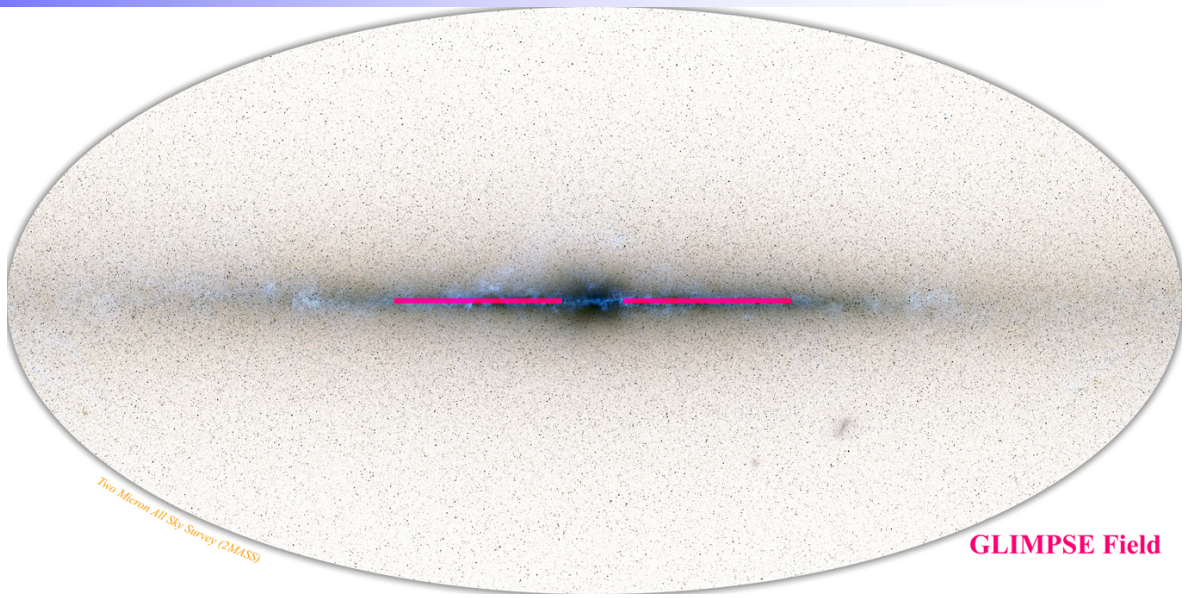
WISE Fills the Gap in Surveys Where JWST Will Observe

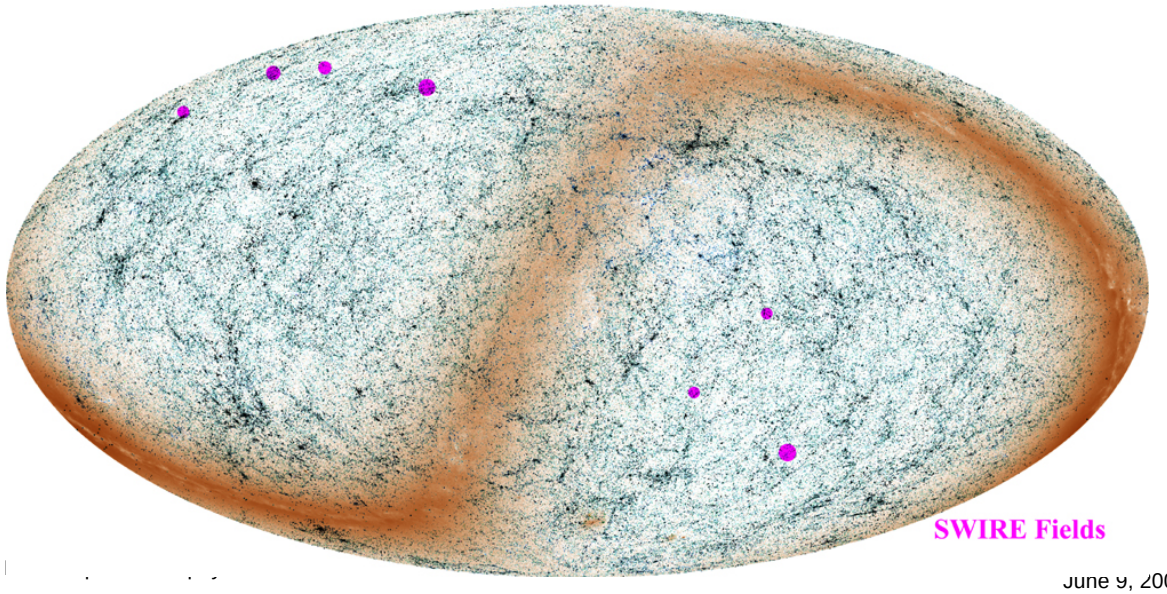


Wide-field Infrared Survey Explorer

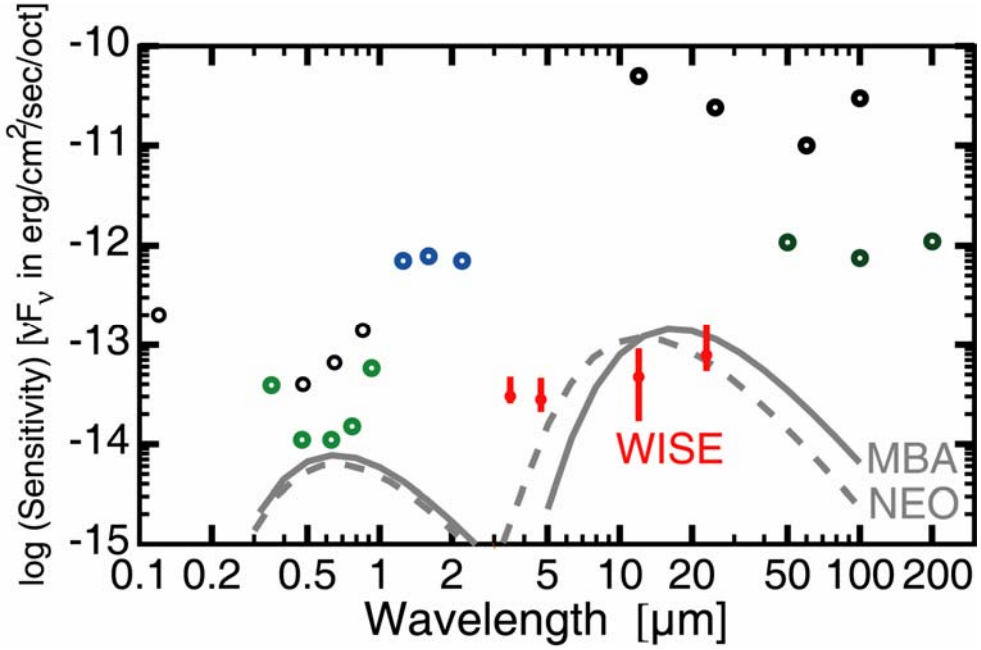
WISE and Spitzer - Complementary Missions

- Detailed information available for Spitzer sources will define characteristics of the most interesting WISE sources
- WISE will survey 170x GLIMPSE and 635x SWIRE area
- For > 99% of the sky, JWST will rely on WISE data for efficient targeting





WISE and Asteroids

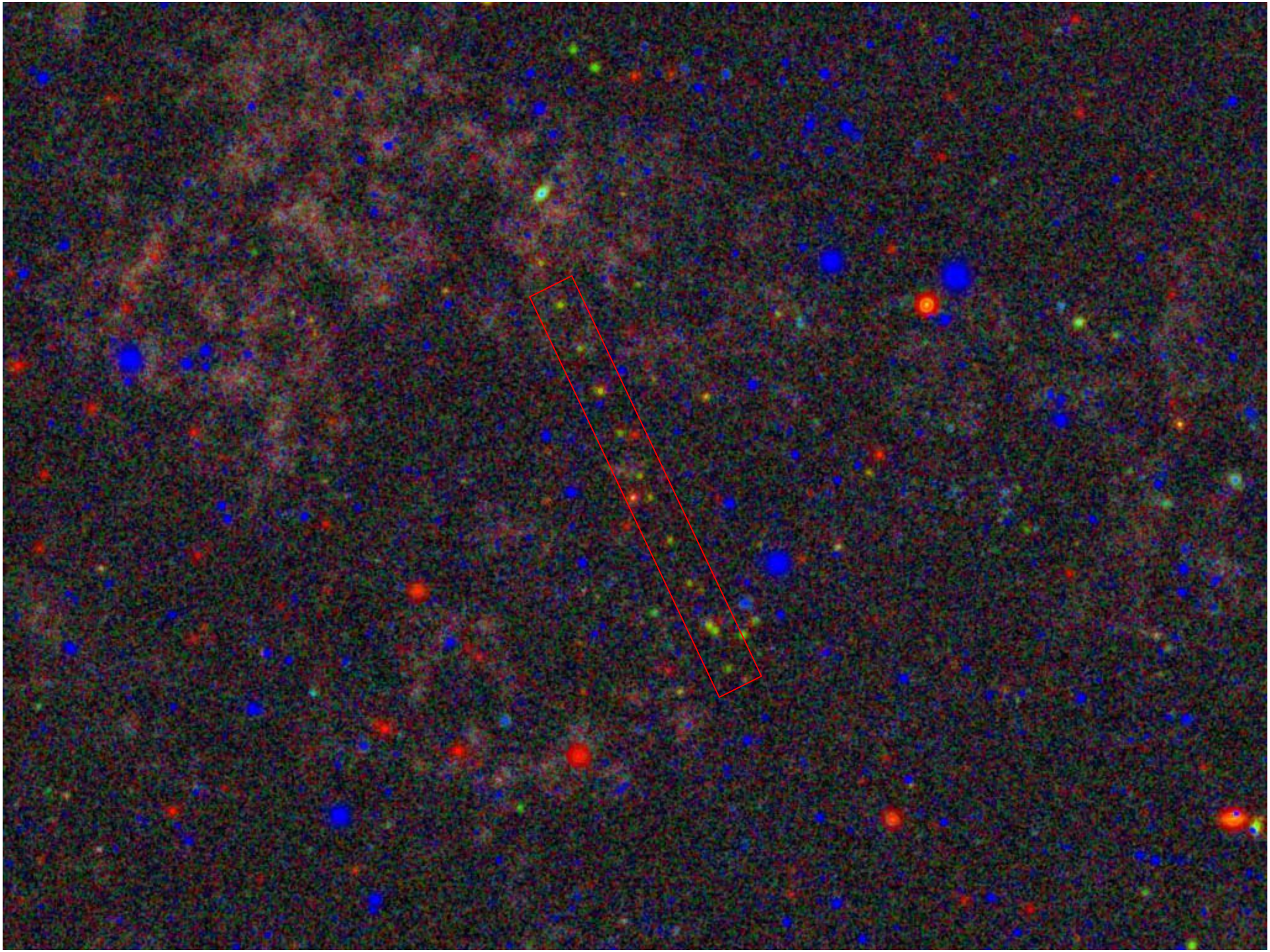


Gaspra

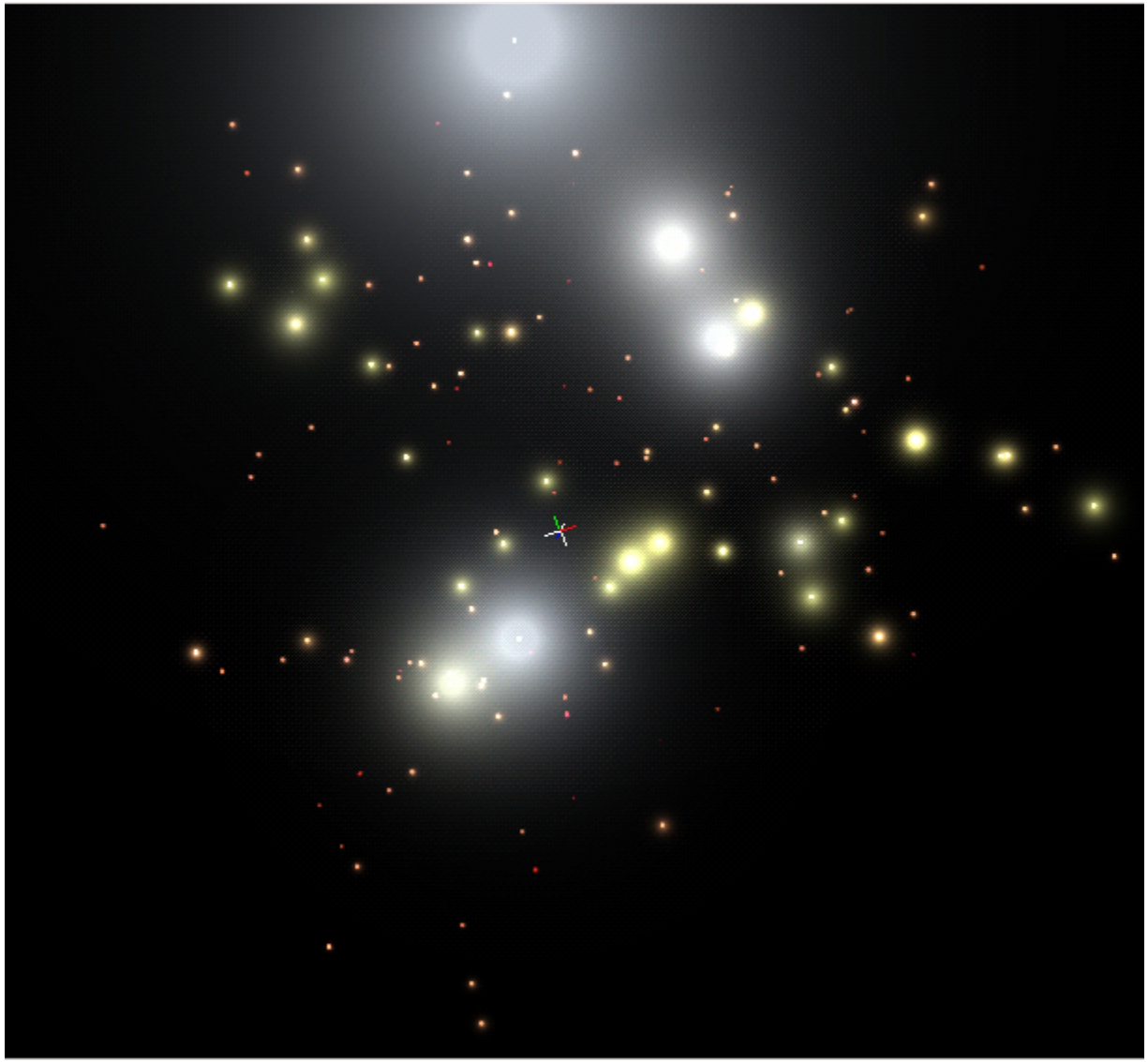
WISE measures diameters of 1.1 km main belt asteroids (MBA) & 230 m near Earth objects (NEO).

- Asteroids are much brighter in IR than optical
- They move in the hours between WISE frames
- WISE will identify ~ 40,000 asteroids
- WISE data provide radiometric diameter estimates for >>100,000 asteroids

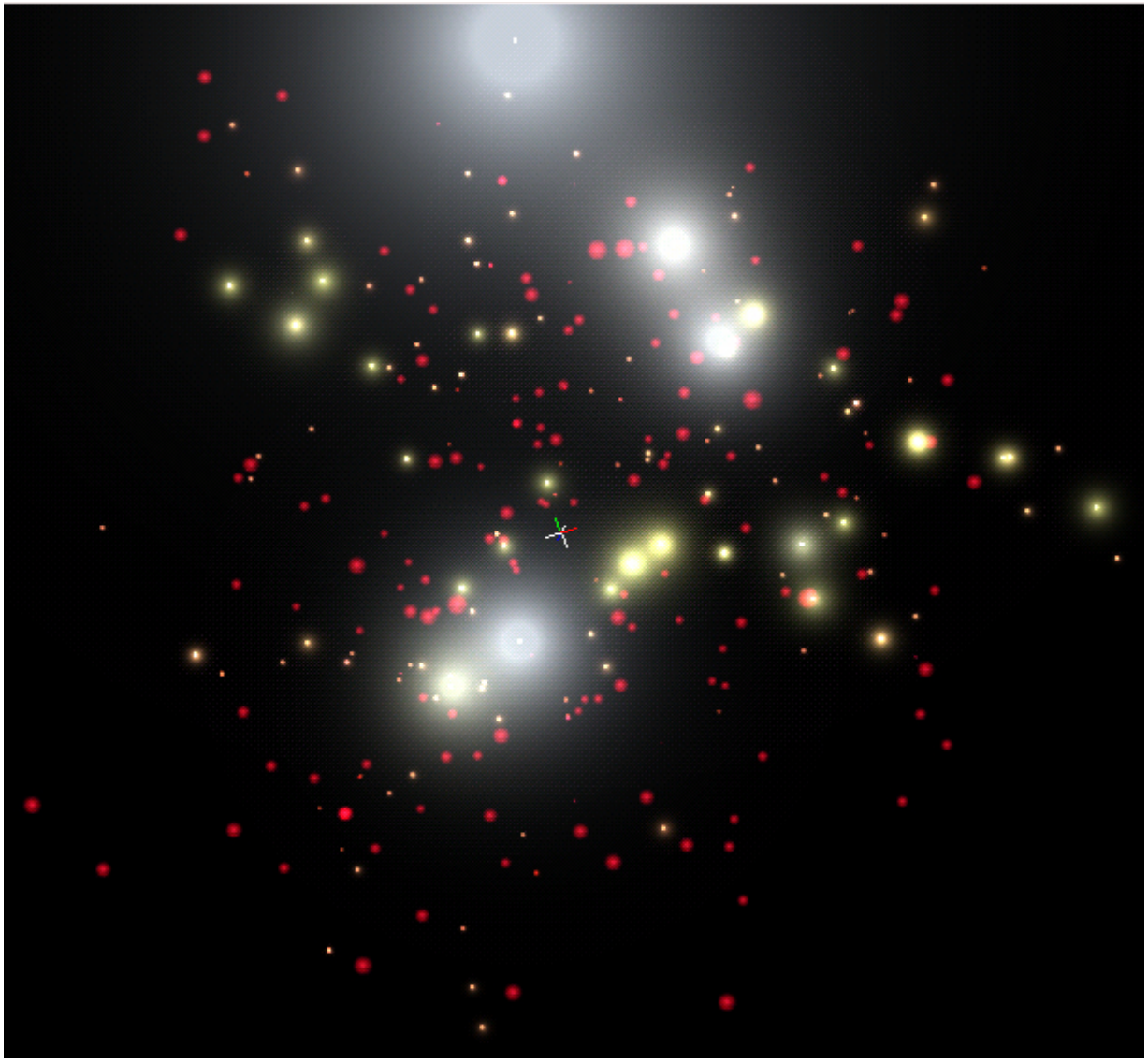
Asteroids move



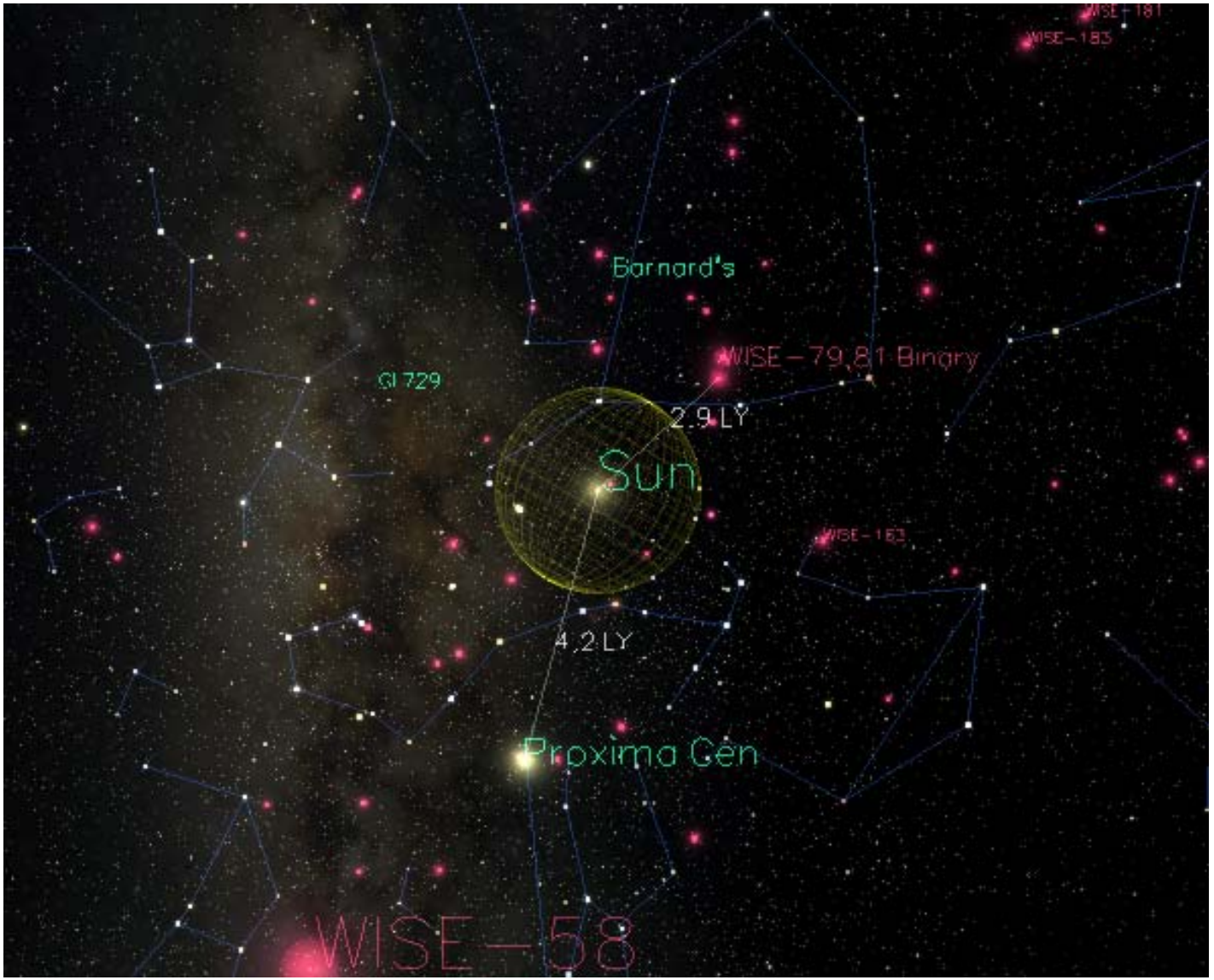
Known Stars within 25 lightyears



WISE stars within 25 lightyears

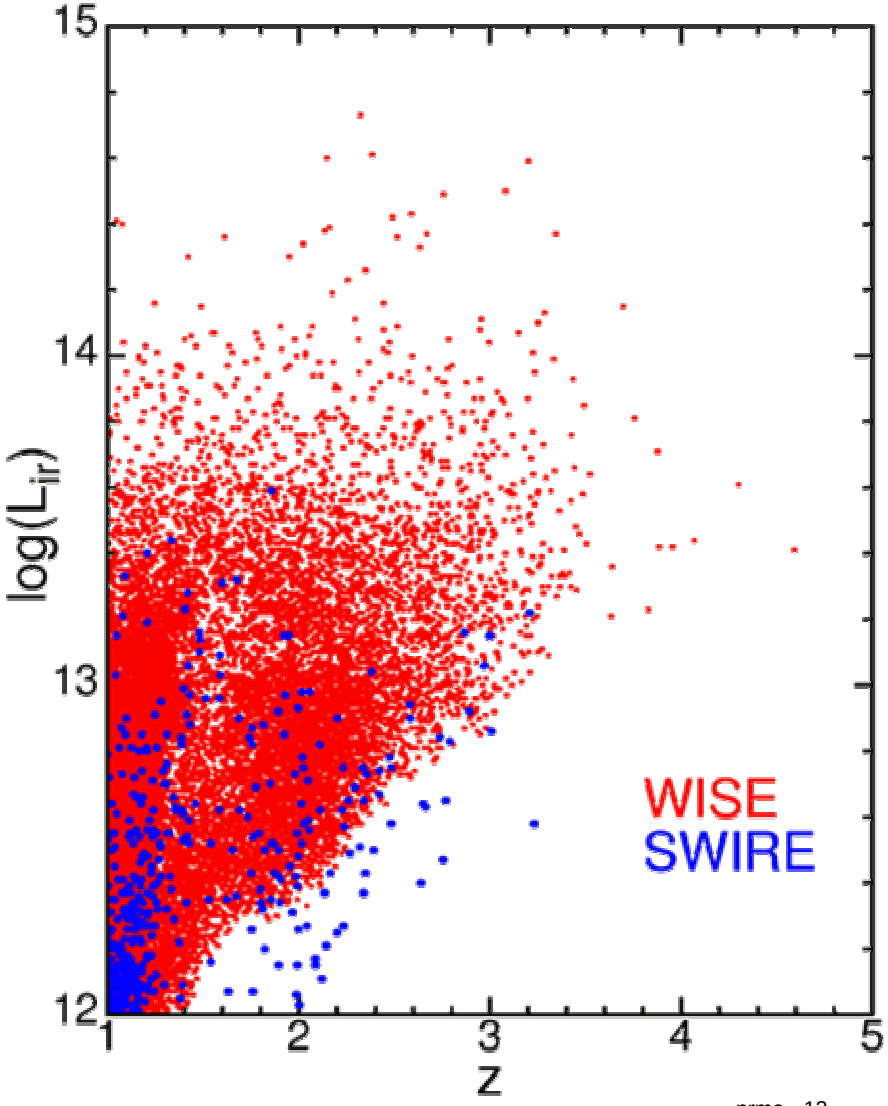


The closest stars…



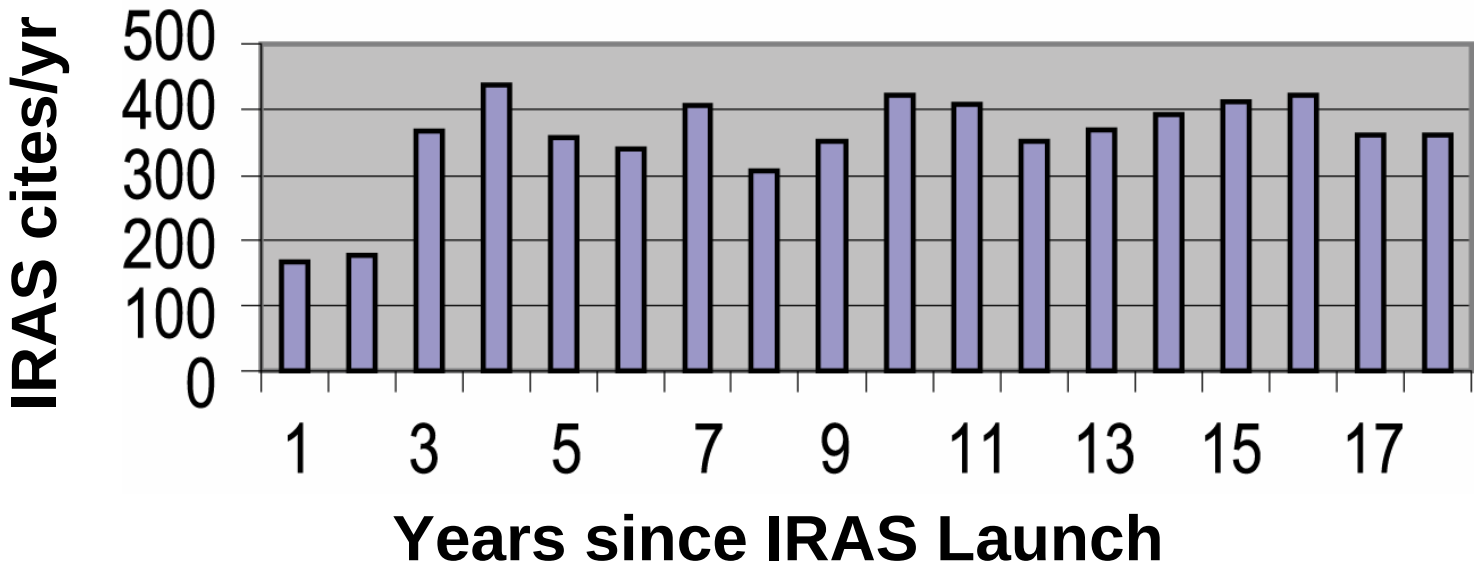
Scientific Context for ULIRGs

- Bottom up structure formation has a hard time producing high z and high L objects, but these ULIRGs are seen.
- JWST will want to observe high L objects at z=15, so an understanding of the high L end of the luminosity function will be important.
- WISE may find objects ~10 times more luminous and with 10 times higher fluxes than the top end of SWIRE, allowing for detailed study by JWST

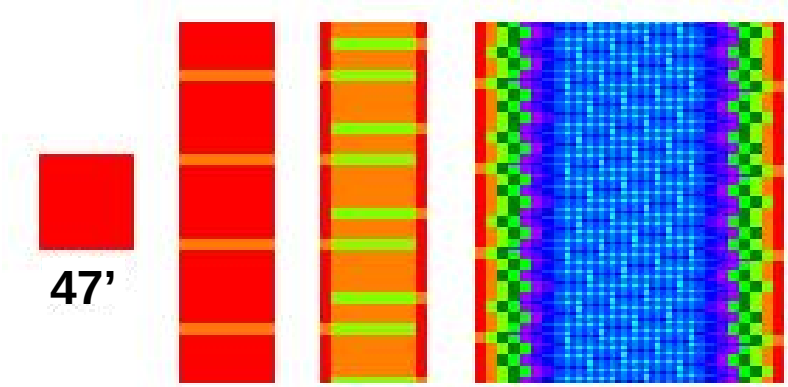


The Legacy of All Sky Surveys Endures for Decades

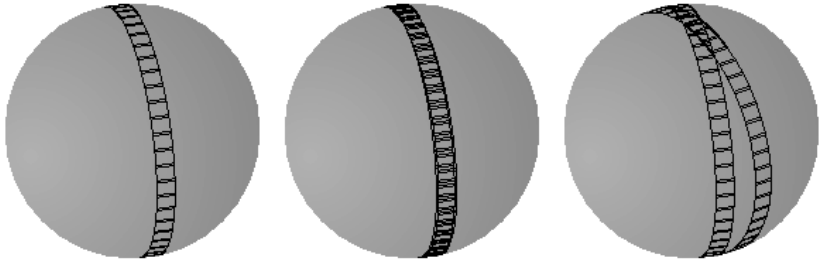
- Palomar Observatory Sky Survey: for 50 years has defined the optical sky
- IRAS: two decades after launch, IRAS is still our best source of knowledge about the thermal IR sky. Still widely cited:



WISE Mission Design



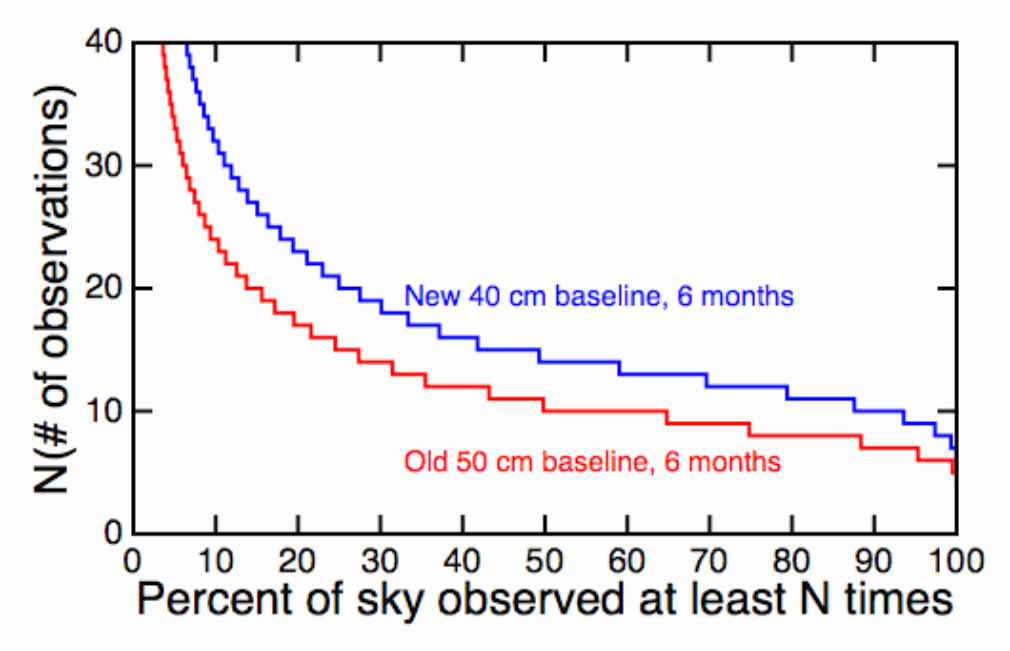
A single frame, a single orbit, two orbits, and many orbits.



- Launch on Taurus 2210 into 500 km, circular, sun-synchronous orbit
- Freeze-frame scanning with scan mirror as in 2MASS and Spitzer/MIPS
- A circle nearly perpendicular to the Earth-Sun line is scanned each orbit
- Precession by 4’/orbit sweeps the whole sky in 6 month science mission (follows 1 month checkout)
- Scan pattern observes each part of the sky 6 or more times after allowing for data lost to SAA and moon.

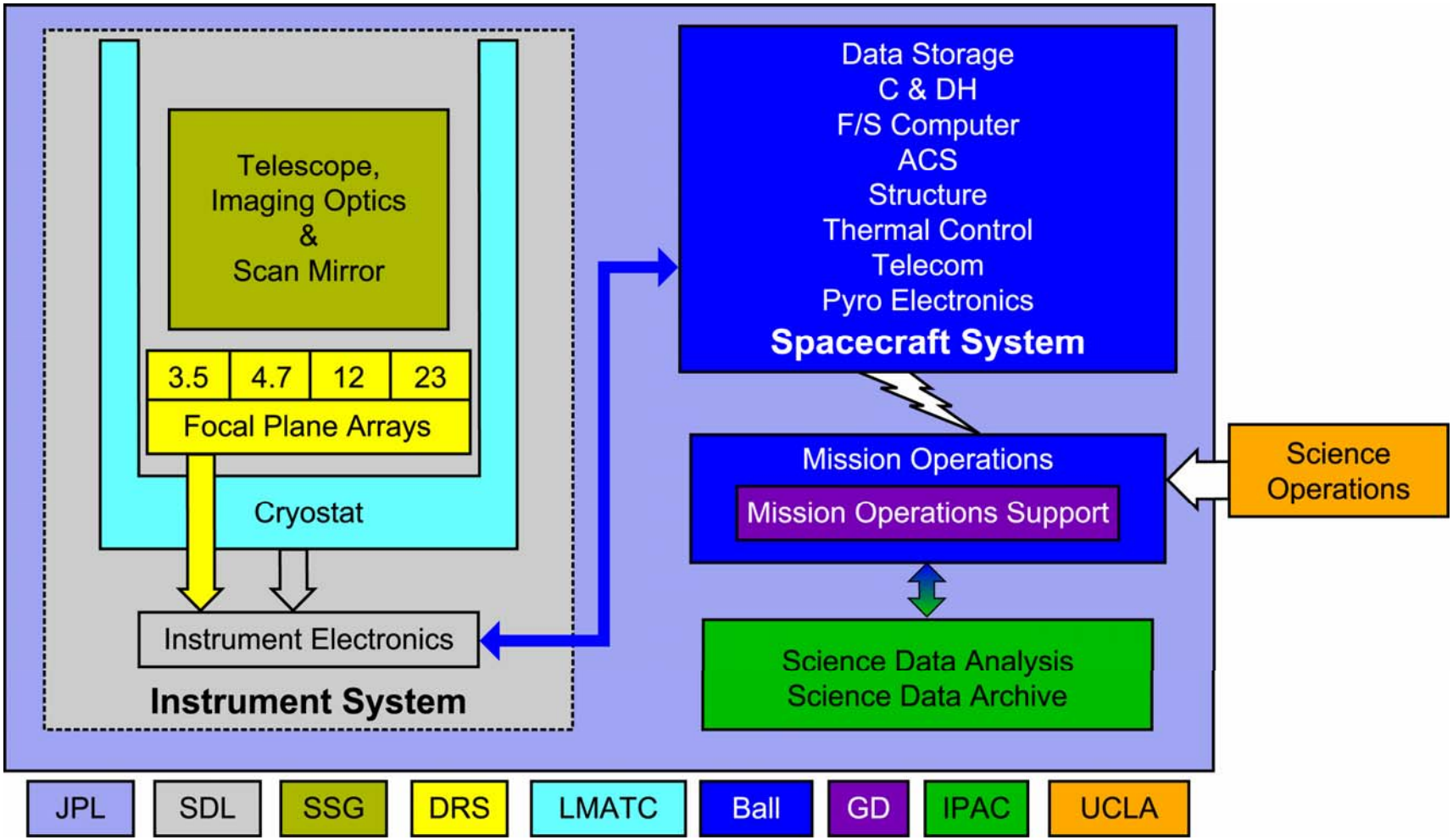
Extended Phase A Has Reduced WISE Implementation Risk

- Primary mirror diameter reduced (50 → 40cm)
- Low noise low T 1024^2 Si:As detector fabricated
- HGA gimbal eliminated
- Data rate decreased (78 → 51 GB/day)
- Launch mass reduced (532 → 461 kg)
- Budget reserve increased (20 → 26%)

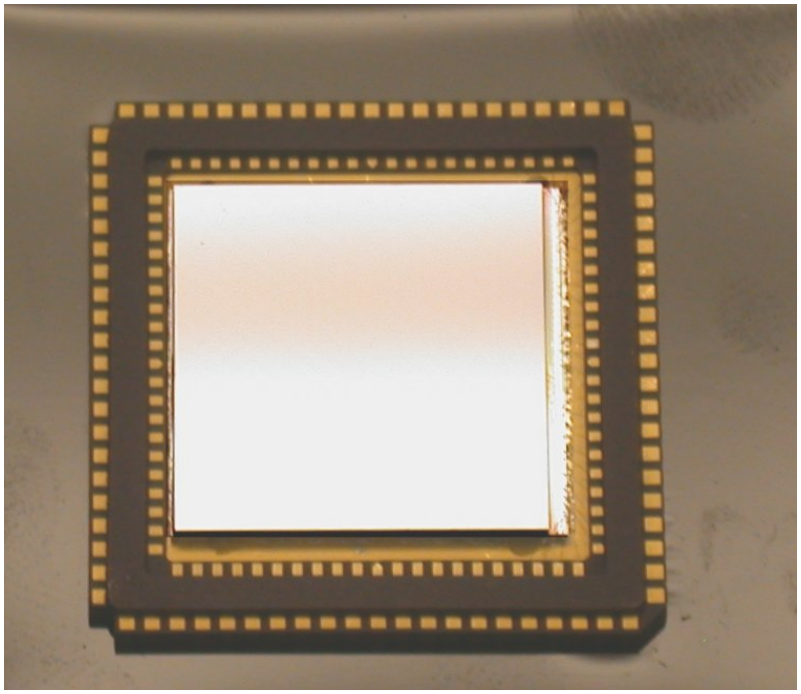


- WISE science reqts set by ULIRGS and brown dwarfs continue to be met
- Revised concept provides more independent observations at all sky locations

System Block Diagram

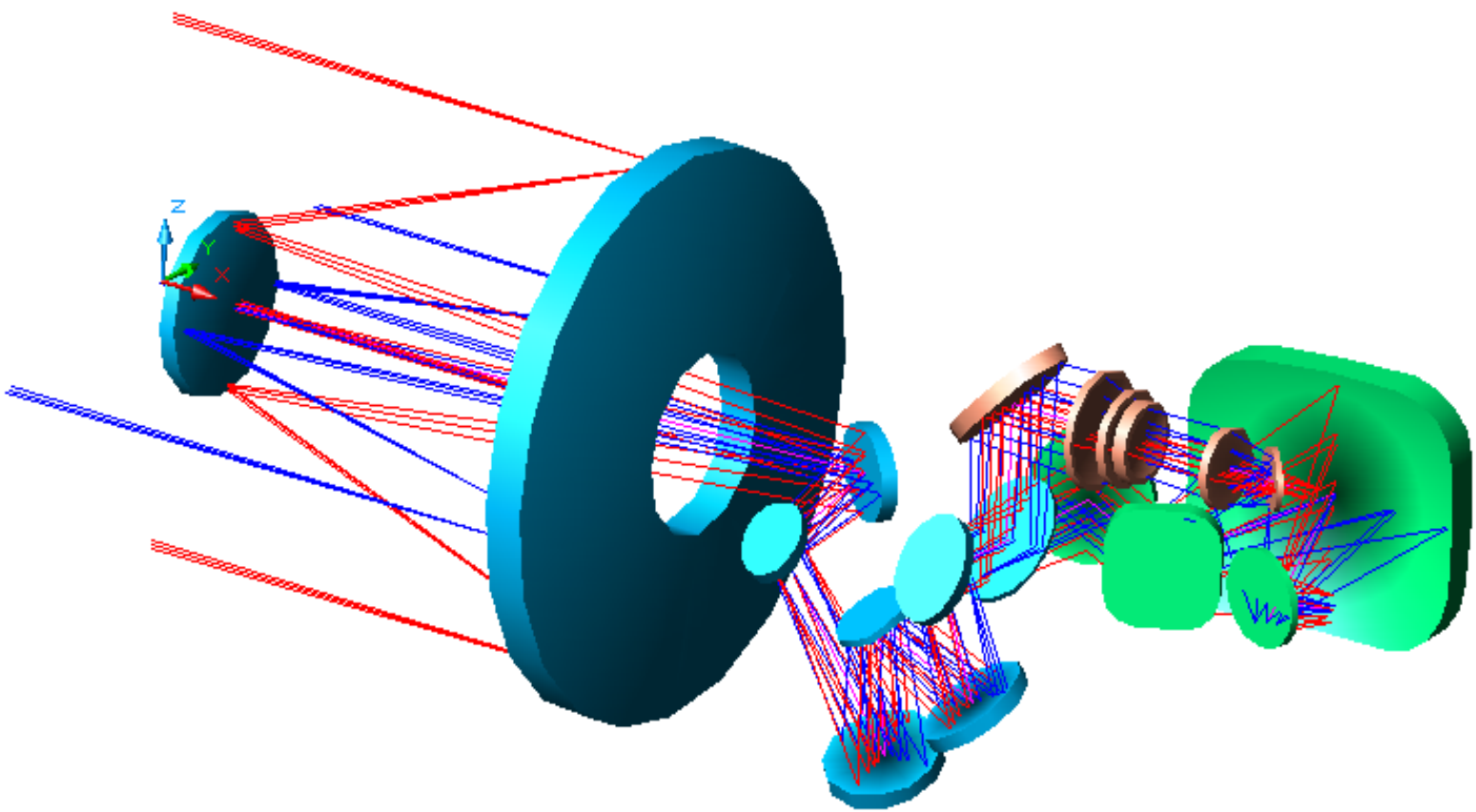


First WISE 1024^2 Si:As Array



- Designed for low noise (< 40 e-) at low T (7.8K)
- Currently under test

WISE Optics



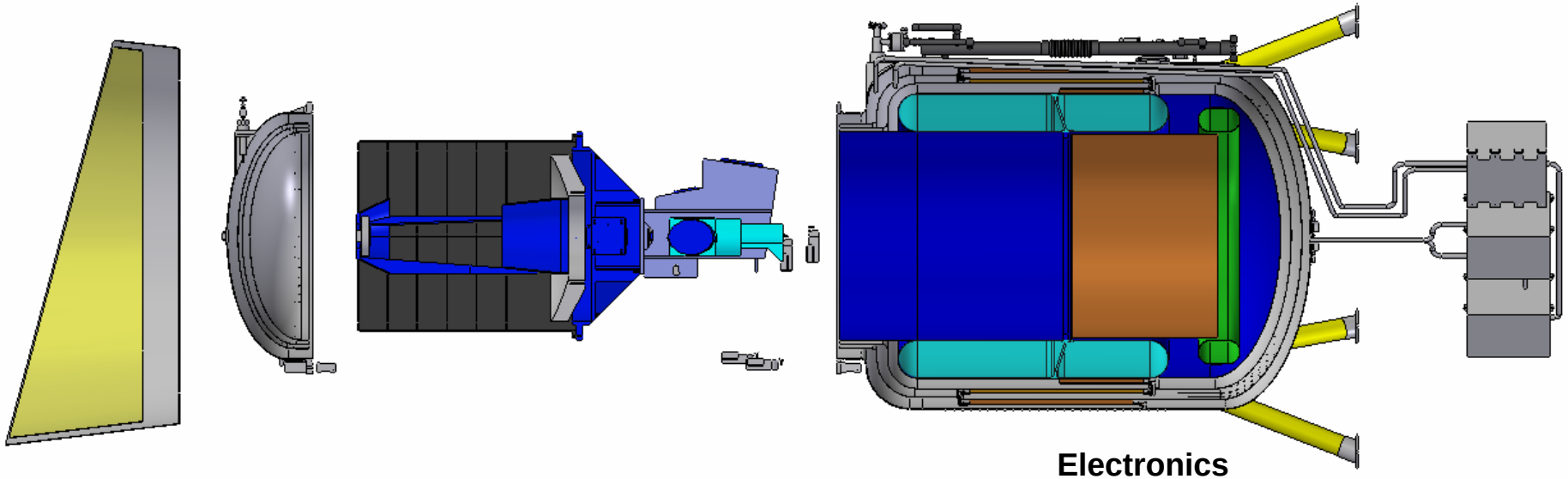
- A 40 cm telescope with a 4 band imager using dichroic beamsplitters.

Payload

2-Stage Aperture Shade
- Radiatively cooled
- Protects aperture from stray sun/ earth radiation
- Inner shade <110 K

Telescope Assembly
- 40-cm afocal front end
- Scan mirror
- Refractive MWIR imager
- Reflective LWIR imager

Cryostat
- 2-stage solid hydrogen
- Secondary tank cools optics & MCT FPAs
- Primary tank cools Si:As FPAs
- 2 vapor-cooled shields
- Composite support-tube structure



Aperture Cover
- Deployed on-orbit
- Seals vacuum space on ground

Focal Planes
- 2 MWIR MCT arrays
- 2 LWIR Si:As arrays
- Cryogenic cables

Electronics
- Focal-plane electronics
- Command/Control/ Telemetry
- Housekeeping/scan-mirror control
- Data compression/Binning

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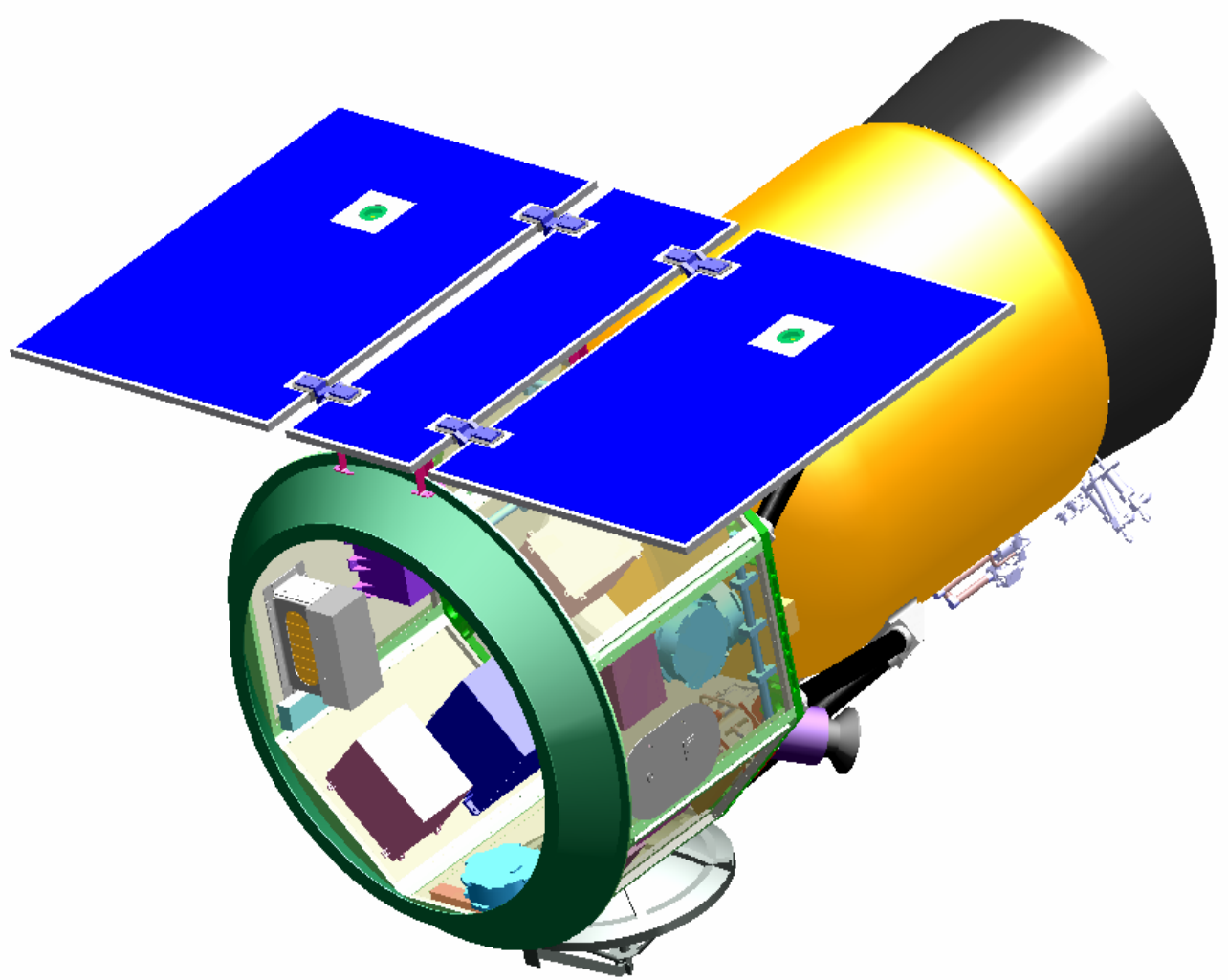
WISE



WISE in Launch Configuration

- Mass
  - 461 kg
- EOL Power
  - 460 W
- Configuration
  - 3 axis, deployed stationary arrays
- Telemetry:
  - TDRSS
- Data rate:
  - 50.6 GB/day (uncompressed)
  - 20.7 GB/day (compressed)
- Data storage:
  - 85.9 GB

Conclusion

- WISE will use state of the art detectors to achieve 500 to 500,000 times better sensitivity than previous all-sky surveys in the mid-infrared
- The all-sky survey will enable WISE to undertake projects which are beyond those feasible for Spitzer:
  - Measure >>100,000 asteroids
  - Find the 2/3 of the stars in the solar neighborhood that have not yet been seen, including the closest stars to the Sun
  - Catalog the most luminous galaxies in the Universe
- WISE will provide a legacy that endures for decades, enabling studies of objects that have yet to be discovered.

"The right time to do the survey mission is before your mega-billion dollar battlestar."

--Edward J. Weiler, in a talk at JPL, March 3, 2003